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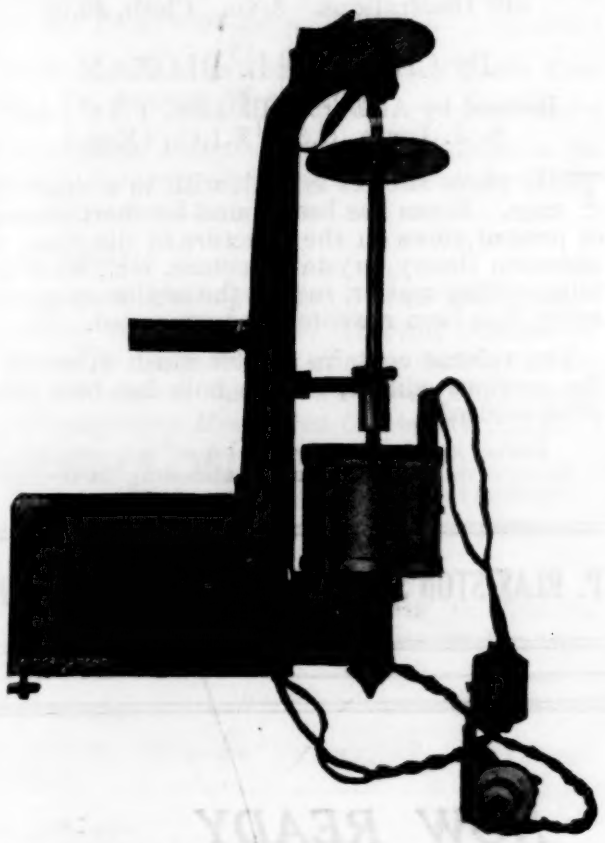

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THE EDUCATIONAL VALUE OF THE STUDY OF QUANTITATIVE ANALYSIS[1]

How often it has been said that the most important and fundamental instinct of man is the creative instinct, and how many morals have been pointed from this conclusion! This, it may be said, is one of the principal causes for the high degree of development of science and for the advanced state of our civilization. But if this is the orthodox scheme for looking at the matter, I am going to venture a heterodoxy by saying that, quite the contrary, the most primal, fundamental instinct of man is that which prompts him to take things to pieces. If you can remember when you were at the tender age of, say, four to ten years, you will probably recall no greater delight than was given by the opportunity to tear down an old watch, a bicycle or a piece of domestic machinery, to see how it was made and what made it "go." Unfortunately it was not always easy to reverse the process, and the thing would not always go when it was put together again. We are all familiar with the ancient story of the boy who took apart the family clock and who somehow could not get it together again without having a quart or so (I mean a liter or so) of wheels and screws left over. And the small boy often "analyzes" the logic of theory and rules of his elders with the same disconcerting thoroughness, neither he nor his elders being able to piece the thing together again into anything that will "go." Many embarrassing and uncomfortable moments in the family life have resulted from this.

All of which merely gives us a chance again to state that we are, by nature and inheritance, analytical and not synthetical. We want to know of what the universe is constructed and what forces keep it operating. Our greatest minds are devoted to the search for the answers to these questions. It is only a logical consequence and a secondary outgrowth of this passion to know the how and why of things that we utilize the results of scientific search for causes and ultimate forms in the construction or "synthesis" of things having a different outward form and inner nature, and having a wider field of usefulness.

In the analytical laboratory of the college and the university we attempt to direct this useful and un-

[1] Read before the Section on Chemical Education of the American Chemical Society, at the New Haven meeting, April, 1923.

quenchable desire for a knowledge of fundamentals along the lines of orderly and systematic investigation of the composition of things. Possibly it is for this reason that the student often feels that this is the first course in his chemical training that offers any prospect of practical usefulness. He is here, at least, utilizing some of his laboratory effort in the pursuit of semi-practical questions. But as we now gain from the quickened interest taken by the student in his work, we encounter a new difficulty in our attempts to keep the scientific aspects of the subject in their proper prominent relation to the practical bearing of the figures which represent the result of the analysis.

Should the primary aim of the college course in quantitative analysis be to impart to the student the necessary equipment for doing and applying practical work in the industries or to train his mind for logical, orderly thinking, in careful manipulation of the methods of quantitative analysis and in scientific methods of general procedure? To many of us the second purpose would appear to be the more important. Without discounting the fact that the analytical methods should be such as apply, so far as possible, to practical industrial and economic problems, we yet feel that the college should give something more than the mere ability to use such methods to obtain accurate results. The steady trend of college education toward the "practical" has resulted in very strong pressure in favor of the mechanical side. At least in the engineering and agricultural colleges there is commonly a feeling among the students in chemistry that any course in quantitative analysis that is not largely made up of exercises which the individual student will use after graduation is more or less a waste of time. This is, perhaps, a natural attitude and it may even be made unobjectionable if the teacher will recognize the fact that almost any analytical work may be administered in such a way as to emphasize the scientific side of the student's training. Unfortunately, the passion for the practical goes even to the extent of demurring to the suggestion of whatever mental effort may be considered by the instructor as necessary for the proper study of principles. Speaking from a considerable experience in teaching this phase of chemical science, I express the belief that there is no part of the work that is more interesting and, at the same time, more baffling than the problem of causing the student to appreciate the value of the quantitative courses as training of the mind in methods of thought and in attitude toward scientific problems. He is constantly weighing the course in terms of its value as a tool to be used in his expected activities after graduation and he does not readily see that the tool, in this case, is general mental and analytical skill, and not simply the accumulation of a repertoire of laboratory methods. From this comes the impatience to be "getting on," the desire to cover a large field in a superficial way, and the disinclination to stop to weigh and consider. Self training and discipline in accurate thinking and manipulation are foreign to this purpose.

This spirit is sometimes allowed to dominate the planning of the course in quantitative analysis. Comparatively large amounts of time are devoted to laboratory exercises and little or no time to consultations, recitations, lectures or outside reading. The work thus degenerates into what is often aptly described as "cook-book" chemistry, the student acquiring little better than a fairly wide acquaintance with the mechanical processes of quantitative analysis. Students who have transferred from other colleges have sometimes come to me for credit in certain elementary portions of my own courses. Questioning would then bring out the fact that they had already covered more ground than I do in all my courses, but with little or nothing in the line of drill upon principles.

This is not my idea of college work. The student might better acquire his smattering of mechanical processes by serving an apprenticeship in an industrial laboratory, where he would not only become skillful in rule-of-thumb methods of certain practical applications but, at the same time, earn a certain stipend instead of spending.

Then there is another attitude that we have to consider—grown up, to a considerable extent, in these latter days of the remarkable development of so-called "chemical engineering" in the colleges. We are familiar with the fact that American industries have only within comparatively recent years begun to see the real possibilities of chemistry in their own development. This has been reflected in the evolution of curricula in our technical schools, designed to meet the need for chemists who have some knowledge of industrial engineering problems and methods. This has had an effect which is generally good but it has entailed certain results in our colleges which, I imagine, were not entirely foreseen and which are not for the best interests of American chemistry. The result that I have in mind is, first, that the great majority of our young men who are looking to the technical college for chemical training are now drifting toward chemical engineering curricula, rather than toward chemistry as one phase of liberal arts or general science training and, second, that their ambitions are directing themselves to an increasing extent toward positions of an administrative character where, as they suppose, their knowledge of chemistry and of engineering will fit them for directing great enterprises in industrial life. This is a fine and a worthy ambition—for the few who are so constituted as to make success along these lines a hopeful prospect. But a considerable proportion of our chemical engi-

neering graduates are not so constituted, as is shown by a study of the present occupations of the graduates of any good chemical engineering school. Of course a certain fraction of these would not be successful in any field of chemistry and some, indeed, would be failures in any field at all. But if we speak only of those who develop a certain talent in chemical studies, it is unfortunate that we now experience such difficulty in interesting them in the possibilities for productive endeavor, mental satisfaction and high accomplishment in what, for want of a better word, we have been calling "pure" chemistry. They feel that the best that the laboratory has to offer them is an understanding of how the chemist and his laboratory are to be utilized in solving plant problems. They have much less interest in the present need of our American industries for men who have a thorough training in chemistry and in methods of research. Quantitative analysis, to one with such an attitude of mind, is merely a place to stop for awhile to acquire a limited acquaintance with a species of animal which he will later, from behind the mahogany desk, order and browbeat and "fire." He does not realize the value of the quantitative courses as a discipliner of mind and hands and as a necessary preparation for directing the highest type of development in applied science. He is not expecting to be a "laboratory man" and if he tries out some methods of analysis and acquaints himself with the general superficial aspects of laboratory technique, any further training in this work would be mere delay in progress toward more important enterprises. Our difficulty, then, is in finding students who are willing to spend time and effort in convincing themselves, by first-hand experimentation, that chemistry is a quantitative science and that it must be studied as such and, incidentally, to accumulate an extensive knowledge of the methods and applications of analytical chemistry as a necessary basis for almost any use of chemistry, pure or applied. We can scarcely overestimate the value of this study to him who is to make any phase whatever of chemistry his major activity in life. And we may go even farther and assert that a reasonable period spent in the study of quantitative analysis can be made of great value to anyone, without regard to the nature of his major activities, as an education in the orderly methods of study and reason employed in all scientific work of every description. To one who has applied himself to this study for even a semester, especially if he has had proper help from a good teacher, the material world has a new meaning and there is a new respect for the work of men of science everywhere.

The various difficulties here discussed may be overcome if the teacher will persist in his determination to teach the subject as a part of the student's education and not as a mere manual training course. There remains another problem, the serious character of which no teacher of experience will desire to minimize. Shall the laboratory for quantitative analysis be made a place for education and mind development, or a training school for scientific crooks and expert jugglers of figures? It may be either, but I believe that it is possible for teachers of this subject to fail to appreciate to the fullest degree the difficulties involved in entirely avoiding the second alternative. The possibilities for obtaining credit by clever manipulation of figures, ostensibly the results of careful analyses, are exceptionally great in this work. Knowing this, we sometimes are inclined to surround our work with obvious preventives and penalties and to treat all our student reports with suspicion.

This is truly a mistake. If we leave out of consideration that small minority of men without conscience or character who may infest almost any class —men who will readily lie or cheat to gain "credit" or "standing" in a class, it may safely be said that the great majority of our students desire to work honestly and to gain credit and benefit from meritorious work. They make honest reports in most cases but occasionally the temptation to make minor falsifications becomes too great and a slip occurs. Probably the most common case of the kind is where the student runs his analyses in duplicate and finds that the results do not check as closely as he thinks the instructor will require. He may or may not know that some small error has occurred in one of his determinations, but he has reason to believe that neither is very far from the correct result. He reasons that he will gain nothing valuable, either in experience or in knowledge, by repeating the work and he yields readily to the temptation to alter the figures from one or both of the experiments so as to make a report that will be acceptable to the instructor.

There is, of course, the more aggravated case of cheating, where the student makes a pure guess at correct figures without any experimental work at all, or where his guess follows a carelessly performed experiment. This is a form of dishonesty which is usually not difficult to detect, if the instructor has a well-chosen and well-prepared set of samples for student analysis and if he knows accurately the composition of these samples. The student is likely to excuse to himself even this obviously dishonest method on the ground that he has already had his experience, that he will gain nothing of value by repeating the work and that by so doing he will fall behind the class and so possibly lose credit for the course. The fallacy of the first part of this hypothesis is obvious to the instructor, though not to the student.

These and other forms of petty dishonesty are pres-

ent in all (or nearly all) classes in quantitative analysis and there is nothing to be gained by closing our eyes to this fact. We have only to consider how we may minimize these practices, so destructive to all scientific ideals, in the most effective way. In this connection I should like to mention one thing which we should not do and this is to preach to the students about it. No one ever pays much attention to preaching, in church or out of it. We have, it is true, certain reports of sinners brought to repentance by the fiery eloquence of the preaching evangelist but this is mostly an appeal through the emotions and, while some few may possibly yield permanently to this appeal, unfortunately too many others relapse into former chicken-stealing habits the night after the meeting closes. No one pays any attention to preaching except to indulge in the pious hope that this or that acquaintance may profit by it. As teachers we may solemnly warn our students that if they once begin the use of beauty-shop methods for preparing reports they will never be able to do honest, accurate work after graduation (which is absolutely true) but, at the time we are saying this, each student, instead of experiencing any remorse for his own possible infraction of the rules, is feeling in his heart that several others whom he could mention would do well to take home the advice and to profit by it. I have tried this sort of procedure on occasion, and I have no reason for believing that it ever did any good whatever. The real truth is (and our reformers, preachers and teachers of every description would do well to consider this) that one's conscience can be made to approve anything whatsoever that one desires very much to do.

Falsification of analytical records is encouraged chiefly in three ways. These are:

(1) By assigning for analysis materials the composition of which is obvious to the student, so that if pressed for time or if accident has ruined a determination he is too strongly tempted to report data that were not obtained experimentally but calculated from known values. This is the case when pure salts, rather than mixtures or commercial products, are employed for student analyses.

(2) By requiring impossible accuracy in the results of students' analyses. Rather, we should carefully explain at the outset that skill is to be attained only by long and careful practice, that a kind of work that is worthy of the best efforts of men and women of college age and serious purpose can not be done with the highest degree of accuracy when one is trying for the first time and that, while we do not tolerate careless, slip-shod work, neither do we expect from a novice analytical work of a character worthy of an expert. This is a policy of simple fair play with the students.

(3) By creating an attitude of hostility on the part of the student. This applies to all teaching. We well know that even our best students are not likely to do good or honest work in any class in which the teacher is disliked or considered unfair or oppressive in his methods or requirements. Any instructor who assumes an attitude of frowning aloofness—of a taskmaster who is intent only upon getting work done—will very likely be unable to keep in his students the state of mind which is a prerequisite for work of character. On the other hand, if they understand that he desires to be sympathetically helpful, using his experience and more extensive knowledge in assisting his students to a better perception of the possibilities of good work, I am convinced that he has thereby taken a most important step in the direction of reducing the cheating nuisance to a minimum.

In conclusion, let me restate my conviction that the study of quantitative analysis, pursued under proper guidance and in correct atmosphere, may be made of the greatest possible value in the acquisition of an appreciation of chemistry as a quantitative science and of all science as the study of rigid, quantitative principles of nature. And surely it can not be doubted that if all serious minded people could catch something of this sort of appreciation, our progress toward a more orderly, and therefore a more happy, state of civilization would be very much accelerated.

E. G. Mahin

Purdue University

THE YIELD OF WHEAT IN ENGLAND DURING SEVEN CENTURIES

Political economists agree that the inclosure of open-field farms in the sixteenth and seventeenth centuries was one of the most important economic events of England. It is said that over a thousand books and essays have been written on this subject in an attempt to reach an understanding of the causes which led up to the medieval system of villages and of communal open farms and the principles that underlay the breaking up of the open fields into inclosed fields where individual effort was possible. Quite recently four very interesting articles have appeared on this subject.[1]

[1] V. G. Simkhovitch, "Hay and history," *Political Science Quarterly*, September, 1913; Harriet Bradley, "The enclosures in England: and economic reconstruction," Columbia Studies in History, Economics and Public Law, Vol. LXXX, No. 2, 1918: Lord Ernle, "The enclosure of open field farms," *Journal* of the Ministry of Agriculture of Great Britain, December, 1920, and January, 1921; Reginald Lennard, "The alleged exhaustion of the soil in medieval England," *The Economic Journal*, March, 1922.

In the discussion there is a considerable amount of information bearing upon the subject of soil exhaustion which probably has not come very generally to the attention of our soil scientists because of the character of the journals in which the papers have appeared. Simkhovitch ascribes the principal reason for the change from the open field to the inclosed field system to the deterioration of the soils and ascribes the change and the subsequent improvement of agriculture to the introduction of hay grasses, of the clovers and of alfalfa. He says:

> The introduction of grass seed and clovers marked the end of the Dark Ages of Agriculture. It is the greatest of revolutions, the revolution against the supreme law, the law of the land, the law of diminishing returns and of soil exhaustion.

Miss Bradley appears to agree that the exhaustion of the soil below profitable returns was the cause of the revolution. She does not place much credence on the statements made by other writers that the Black Death was the principal cause nor that it was due to the increased price of wool and to the cupidity of farmers who insisted that the raising of sheep, which was incompatible with open-field agriculture, was the principal cause, nor does she think it was due primarily to the growth of industries.

Lord Ernle in his first paper gives a very interesting account of the general methods of medieval agriculture, of the open-field system, and the historical development of the inclosure of open-field farms. In his second paper he expresses a very decided opinion that soil exhaustion was the main cause of the inclosures. He accepts a statement supposed to have been made by Walter of Henley that in the thirteenth century a yield of 10 bushels per acre of wheat could be expected and then shows by numerous records of yields obtained from the old manuscripts that the yields of wheat in the fourteenth century were around six and a half to seven and a half bushels per acre. He accepts this as conclusive evidence of the exhaustion of soils in the one hundred-year period, due to the loss of plant food from soils which were insufficiently fertilized. He says:

> It was not till the period 1485 to 1560 that the inclosing movement, long in progress, reached a height which alarmed the country. . . . tempted by the high prices of wool, so ran the charge, the land owners, and especially the new ones, evicted the open field farmers from the arable land, meadows and common pastures of the village farms and turned the whole into sheep walks. . . . The evidence collected by the commissions of the sixteenth and seventeenth centuries goes to show that inclosures of whole townships were rare. The period coincides with the breaking up of feudal households, the dissolution of the monasteries, and industrial reconstruction. . . . Between 1577 and 1689 most of the changes which have revolutionized British farming in the nineteenth century were discussed and foreshadowed in agricultural literature. We have, for example, the field cultivation of rape, of trefoil or Burgundian grass and of turnips suggested in 1577. Lucerne followed early in the next century and potatoes in 1664.

In addition, he has to say:

> With arable lands of open fields subject to common rights while fallow, or from corn harvest to seed time, it was impossible to introduce new crops. Rotations were limited and fixed by immemorial usage. No individual could use hand or foot to effect improvements without the unanimous agreement of the whole body of joint occupiers. If one man sowed turnips it would be the live stock of the community that would profit. Better stock breeding was impossible when all the grazing was in common. The difficulties of drainage were enormously increased by the necessity of securing cooperation. . . . What was wanted was a lead, and in the eighteenth century it was given by the land owners. They initiated experiments; and poured their money into the land. Farms were at great cost adapted to modern methods by new buildings, roads, fences and drainage. Much of the land was literally made during the period. A wave of agricultural enthusiasm rose with each decade of the period until at last it swept over the country. The introduction of roots, clover and artificial grasses solved the problem of winter keep. It enabled farmers to carry a larger head of stock; more stock yielded more manure; more manure raised larger crops; larger crops supported larger flocks and herds; which were both better bred and better fed. . . . Inclosure was no longer a question only of social or agricultural advantage; it had become one of economic necessity. The pressure steadily increased in severity. It culminated during the Napoleonic Wars when every pound of food became of national value. At the declaration of peace in 1815 the old system of common cultivation had practically disappeared and the newer system of individual occupation was almost universally installed in its place.

Lennard takes exception to Lord Ernle's view of the exhaustion of soils. He calls attention to the fact that it was not Walter of Henley who made the statement accepted by Lord Ernle that the yield of wheat in England during the thirteenth century was 10 bushels per acre, but that the statement was made in an anonymous paper evidently published about the same time and that the statement evidently referred to what should be and not as to what was. He then gives the yields from 45 estates in the thirteenth century and from 35 estates in the fourteenth century. He admits some doubt as to the statistical correctness of the yields given, as it appears uncertain whether the acreage used was of the year before or of the year of the harvest, that is, the seeded acreage for the following crop. He also says that there is doubt as to whether the yields were reported before or after the tithe was extracted. He thinks the probabilities are that the measure is the measure that came to the farmer and therefore the tenth part that was given

for tithe was not included. Making allowance for the tithe, he estimates the yield in the thirteenth century at six and a fourth to six and a half bushels per acre and for the fourteenth century at seven and a half to seven and three fourths bushels per acre.

He then asks the pertinent question that if, according to Lord Ernle, the yield had dropped from ten bushels in the thirteenth century to between six and seven bushels in the fourteenth century what would the yields have been at the time of the Norman conquest? In conclusion, he says:

> In regard to the problem as a whole I wish to emphasize the fact that I do not profess that the evidence I have brought forward is adequate to prove or even to make probable any positive conclusion. I am not prepared to maintain that the yield of corn improved or even remains steady in the later Middle Ages.

The quotations given above carry sufficient information about the open-field culture that was dominant in England during the Middle Ages and shows how difficult it would have been to have introduced any modifications. The system was rigid and inelastic to an extreme. However or whenever the system of open-field cultivation was started, an attempt was made by the military, monastic and political forces to maintain it for its social advantages long after its economic failure had been realized.

It must be remembered that in medieval times the object was for the people themselves to be satisfied to gain a living from their farms. There was not a large urban population in England at the time. There were few industrial workers at that period who had to be fed. The transportation facilities were execrable, and it was a period and a system under which the least possible crop was removed from the farm. Therefore, soil exhaustion due to the removal of plant food from the soil would have been at its lowest ebb.

It is admitted by every one who has looked into the matter that the system and methods of agriculture in England during the medieval period were very crude and very poor, and that they finally broke down towards the beginning of the seventeenth century when the open-field method gave way to the inclosures and that this period was coincident with the end of the baronial and monastic periods. It is admitted further that from the beginning of the seventeenth century methods of agriculture began to improve with a consequent increase in the yield per acre of wheat.

It is highly desirable that, through diligent research into old manuscripts, reports and commissions' investigations, the yields per acre for each of the centuries be as accurately determined as possible to establish the level of agriculture under the medieval system and the rate of increase under the more intelligent methods used since then.

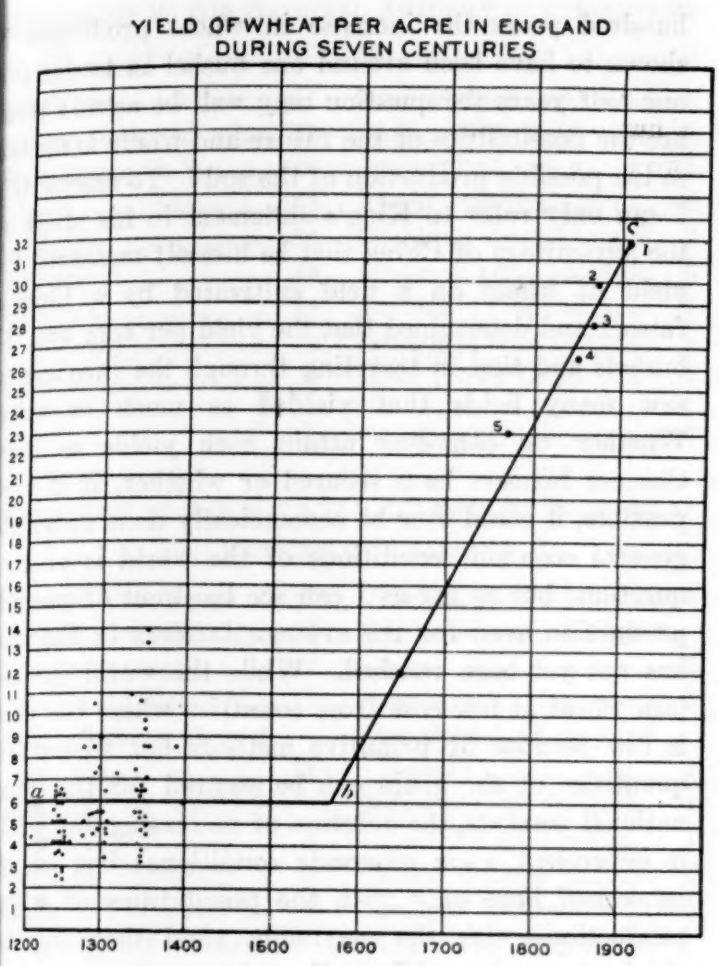
The political economists have given a great deal of attention to the yields in the thirteenth and fourteenth centuries, which marked the beginning practically of written records. They have succeeded in establishing a number of more or less accurate figures for these two centuries, but they have not given us yields in the fifteenth, sixteenth and seventeenth centuries. It is admitted by them that there is probably a wealth of information to be obtained by any one who will take the trouble to search the records of those three centuries, and this should by all means be done, preferably by some one in England who can obtain access to these old figures through the libraries and through baronial and monastic records and Parliamentary reports of many inquiries that have been made from time to time into the state of agriculture.

In the following figure I have drawn a line a—b—c which appears to me to furnish a reasonably satisfactory basis to represent in a crude way the yield of wheat per acre during these seven centuries.

I have indicated on this figure the 45 yields given by Lennard in the thirteenth century and the 35 yields which he gives for the fourteenth century. The average yield of the thirteenth century without allowance for tithe is five and one fourth bushels. The average for the 35 yields in the fourteenth century is six and three fourths bushels. I have considered that under the circumstances this difference of one and one half bushels between the two centuries may be considered as insignificant and I have therefore drawn the line a—b approximately midway between five and one fourth and six and three fourths and have taken an average of six bushels per acre.

Starting with c on the line b—c we have the average of the official British figures for 1909–1913 as given in the year book of the United States Department of Agriculture for 1922. The second dot is the figure determined as the average yield per acre in Great Britain in 1873 by the International Statistical Congress at St. Petersburg which arranged to have the average yields of the principal countries determined. The third dot is an estimate by Sir James Caird of the average yield of wheat in England for 1868. The fourth dot is an estimate of Sir James Caird of the yield in 1850, the fifth dot is the estimate of Arthur Young of the average yield in England in 1770. I have inserted a dot at 1650 indicating a yield of 12 bushels per acre, as it is my impression that the yield of wheat per acre in England at that time was around that figure. From here the line is extended until it meets the line a—b at about the year 1570.

The lines a—b and b—c of course do not meet at the point b at an angle, but the two lines should be connected with a curve, the form or radius of which can not be determined without a sufficient number of figures. As drawn, the line b—c has a slope of about eight bushels per one hundred years, or an increase of one bushel in twelve and one half years.



It seems to me that a horizontal line somewhere around the average yield of six bushels per acre will probably be found to be a very satisfactory basis of the yield of wheat with the method prevailing under medieval conditions and that if we could establish the facts this same level could have been extended back for a period of a thousand years during which time the methods and system of agriculture had not materially changed.

During the whole of the medieval period in England, life was comparatively simple. There were few people whose occupations required them to be fed by labor other than their own; there was a very small proportion of urban population. There was little or no trade in agricultural products within the kingdom or with neighboring states on account of the difficulties of transportation. There was no necessity and little opportunity for the production of large crops. There were a few thoughtful men as there are in all ages who were dissatisfied with conditions, who thought they could be bettered. The early English agricultural writers, such as Tusser and Fitz Hubert, were thundering for reforms, but reforms only came when necessity drove, when in the sixteenth and seventeenth centuries the urban population increased, the industrial age began and the lack of sufficient food for the non-producers caused bread riots and the demand for inclosures where individual effort could be rewarded. Not until then was the old system finally swept away to give place to the new.

As the inclosure system began to prevail over the open-field system, the introduction of grasses, of clovers, of lucerne, of turnips and of potatoes became possible. Drainage began to be installed where needed. The selection of seed, the rotation of crops, the improvement of cattle, sheep and hogs, the improved implements, the improved transportation facilities and above all human and personal desires and aspirations, the use of marls and of guanos and later the introduction of bones and of commercial fertilizers made possible a better system of agriculture which has tended steadily to increase the yield per acre of wheat.

The introduction of these improved methods had little or no effect upon the average yield of the country until the methods had permeated and affected the practice of a large proportion of the farmers. With a million men engaged in agriculture, the combined labor of all making up the average, it was not until the methods had been adopted and intelligently used by a majority of the million farmers that the average yield of the country could be materially increased. So it is reasonable to expect that when we obtain sufficient figures the line b—c down to somewhere near the point b and extended over three centuries will be a nearly straight line with no jogs which could be attributed to the introduction of clover, or to the improvement of livestock, or to the introduction of fertilizers, for these methods spread but slowly through the mass of farmers, the efforts of whom in the mass make up the average.

Let us look at the probabilities of the line a—b at the six bushels level with the methods employed under the medieval system of agriculture. Thorold Rogers, from the records of Merton College, shows that in 1334, 1335 and 1336 the yields on their estate at Gamlingay were respectively, six, seven and one half, and three and one tenth bushels. In the same years the average yields per acre of wheat on their estate at Cuxham were 15.1, 15 and 15.2 bushels per acre. He considers these yields higher than the average, because during this period the price of wheat was lower than the average of the periods before and later, indicating a relative abundance of wheat in these years and consequently a relatively high yield per acre. From the figures furnished by Lennard the yield ranges from about two and one fourth bushels per acre to as much as 14 bushels per acre with an average for the two centuries of somewhere around six bushels per acre or, with an allowance for tithe which may have been deducted, six and one half bushels per acre.

The average yield of wheat in the United States forty-odd years ago was around 12 bushels per acre. It is now in the neighborhood of 15 or 16 bushels per acre. There are some six million farmers

at the present time, a large proportion of whom are raising wheat, which affects this average in proportion to what they produce. Is it not safe to assume that a considerable proportion of our farmers are using methods that yield them about the same returns as the farmers of England obtained under medieval systems of agriculture? Have we not, all of us, seen examples of a tenant farmer with insufficient capital, with poor and decrepit livestock, without ambition or adequate training, use methods not unlike the medieval methods and by injudicious cultivation, by inefficient methods, bring down the yields of even our better farms to a level of the yields obtained by the medieval farmers of England?

On the unfertilized wheat plot at Rothamsted the yield of wheat has declined to an average of about 12 bushels per acre. If this plot had been cultivated with insufficient capital, with half-starved animals and if the weeds had not been rigorously subdued by a laborious system of hand-picking, the yield of wheat on this plot would probably have come down to the yield of wheat under medieval conditions and with a much more rapid decline than has actually been experienced. It is safe to say that in a period of five years on most of the soils of the United States the yield of wheat could be brought down to the yields obtained under medieval methods in England if those same methods and conditions were revived now in this country. It does not take centuries to impair the productive power of soils. It requires only a few years of the life and effort of a man to lower the level of productivity to that of the medieval English farmer.

On the other hand, many of the long-time fertilizer and rotation experiments of modern times have shown that in a period of from five to fifteen years through intelligent methods yields equal to the present English yields can be obtained by the individual farmer. They have obtained these larger yields by rotations alone, by the application of fertilizers alone, or with a combination of fertilizers and rotations.

These things are well known and yet with all of our experience and all of our knowledge we must consider that these improved methods must be adopted by a large proportion of our farmers before they sensibly affect the average yield of the country.

So it seems to me that the low average yield in medieval times must be ascribed to the methods, to the system, rather than to any loss of plant food from the farm and that the increased production of England to-day must be ascribed to the methods, system, and to the higher average intelligence of the man who works the soil.

If, by further research of the political economists or the soil experts, the line b–c is found to be substantially correct or if on the average in the past three hundred years the increase in wheat production is shown to have been around one bushel in twelve and one half years the question may well be asked: What are the possibilities of the future and where is the end to the possible production of the soil? To answer this I can only refer to King's statement in his study of the agriculture of China that he himself measured the yield of wheat on a field cultivated by a Chinese farmer and determined that the yield per acre was 117 bushels and that in traveling through the province he saw many fields that yielded as much or more. Whether we can ever attain such yields as these Chinese farmers have secured or whether, if it were possible, it could ever be economically done under the general economic conditions of the world is another question; but so far as I can see the limit of possible production even for the average farmers in England has not yet been reached. While the world can obtain wheat at low cost from countries where the yield is low because of primitive methods but where vast quantities of the grain can be secured for the international markets, the question of increasing our yields is dependent upon economic conditions; but we are concerned here only with the possibilities of wheat production—with the maximum yield that may be obtained, and in weighing the evidence for or against soil exhaustion, as this term is usually understood.

MILTON WHITNEY

BUREAU OF SOILS,
WASHINGTON, D. C.

THE GEOGRAPHICAL DISTRIBUTION OF MEMBERSHIPS IN THE NATIONAL ACADEMY OF SCIENCES

THE geographic distribution of membership in the National Academy of Sciences is a subject which has interested me for several years. At my request Dr. Aitken has prepared for SCIENCE the tabulations of membership distribution in the academy, as set down below, on the basis of states in the Union, and of universities, colleges and research institutions. Three members of the academy are at present residing outside of the continental area of the United States—at Manila, P. I., at Arequipa, Peru, and at Freiburg, Germany; these have been credited respectively to Washintgon, D. C.; Cambridge, Massachusetts, and Chicago, Illinois, in the several tabulations. The number of members assigned to the individual states or institutions may be in error here and there to the extent of one member, because changes of address may be unknown to us; but these possible defects can scarcely affect the significance of the tables.

MEMBERSHIP IN THE NATIONAL ACADEMY OF SCIENCES BY STATES

New York	41	Pennsylvania	4
Massachusetts	39	Ohio (Cleveland district)	4
Washington, D. C.	27	Rhode Island	3
Illinois	23	Michigan (Ann Arbor)	2
California	21	Missouri (St. Louis)	2
Connecticut	18	Arizona (Flagstaff)	1
Maryland	14	Indiana (Bloomington)	1
New Jersey	8	Iowa (Iowa City)	1
Wisconsin	8		
		Total	217

MEMBERSHIP IN THE NATIONAL ACADEMY OF SCIENCES IN INSTITUTIONS OF LEARNING

Harvard University	27	University of Michigan	2
University of Chicago	17	Northwestern University	2
Yale University	17	Washington University	2
Columbia University	15	Case School of Applied Science	1
Johns Hopkins University	13	University of Indiana	1
University of California	8	University of Iowa	1
Princeton University	7	Vassar College	1
Stanford University	7	Carnegie Institution	9
University of Wisconsin	7	Smithsonian Institution and National Museum	8
Cornell University	6	Rockefeller Institute	6
University of Illinois	4	U. S. Geological Survey	5
California Institute of Technology	3	Bureau of Standards	3
University of Pennsylvania	3	American Museum of Natural History	2
Brown University	2	U. S. Department of Agriculture	2
Clark University	2	Miscellaneous	32
Massachusetts Institute of Technology	2		
		Total	217

If on the map of the United States a broken line be drawn from Salem, Massachusetts, on the Atlantic Coast through Schenectady, Ithaca, Pittsburgh and back to the Coast through Washington, D. C., the area defined will contain the residences of 154 out of the 217 members of the academy, or 71 per cent. A broken line from Cleveland through Ravenna (Ohio), Bloomington (Indiana), Urbana (Illinois), Chicago, Madison and Ann Arbor will enclose the residences of 38 members, or 17.5 per cent. A line in California starting at Berkeley, and passing through Palo Alto, Mt. Hamilton, Pasadena and ending at La Jolla will carry 21 members, or 10 per cent. Only 4 members are left to represent the remainder of our country: 2 at St. Louis (Missouri) and 1 each at Flagstaff (Arizona) and Iowa City (Iowa); in other words, excepting 21 members in California there are only 4 members living west of a north and south line drawn through Madison (Wisconsin). There is no member in the part of the country lying east of the Mississippi and south of a line drawn from St. Louis through Bloomington (Indiana), Pittsburgh and Washington, D. C., and there is no member in the three New England States north of Massachusetts. Six states and the District of Columbia contain 183 members, and 10 states contain the remaining 34 members; 32 states out of the 49 divisions have no members.

It should be said that the policies of the National Academy of Sciences have limited its memberships to representatives of the physical and biological sciences, with very few exceptions. The distribution of memberships seems to be worthy of the thoughtful consideration of all who are in any way responsible for the higher educational interests of the nation.

W. W. CAMPBELL

BERKELEY, CALIFORNIA

SCIENTIFIC EVENTS

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION[1]

THE meeting of the British Association which concluded on September 19 was in many ways notable, and marked the successful introduction of various changes in the local and scientific proceedings. In point of numbers it was the third largest meeting (Australia in 1914 excepted) in the long history of the association, but the actual number of tickets taken is not the only criterion for success. Figures are, however, of some value; for one of the objects of the association, namely, to spread knowledge of science and what it stands for, can be most successfully accomplished by an appeal to the public receiving ready response.

While the membership numbered 3,296, not less than 15,000 people attended the free public lectures in Liverpool and the surrounding boroughs, while more than 7,000 paid admission to the Scientific Exhibition held under the auspices of the association in the Central Technical School on September 10–22, and this number does not include members of the association itself, who were admitted free.

Further, the sectional meetings were almost all not merely well attended but often overcrowded, a condition which spoke well for the enthusiasm for scientific knowledge among the members, but also illustrated the attractiveness of the programs.

The inaugural meeting, when the president delivered his address, was remarkable for the fact that the whole proceedings were broadcasted, and in two halls in Liverpool the wireless version was accompanied by lantern illustrations identical with and shown simul-

[1] From an article in *Nature* by Dr. Alfred Holt.

taneously with the originals shown during the address itself in the Philharmonic Hall. The address was well heard in most parts of the British Isles, and was even picked up so far away as Switzerland. This is, indeed, an example of the development of physical science since the last Liverpool meeting held in 1896.

The place of the customary second evening lecture was taken by a most successful scientific soirée given by the local committee at the university. A wonderful series of experimental and other exhibits had been arranged and a most comprehensive program had been prepared, but unfortunately, owing to the awkward lay-out of the university buildings, it must have been nearly impossible for very many of the large and enthusiastic gathering to see properly one half of all the interesting things on view or to hear many of the excellent series of lecturettes. Such a soirée, however, is full of value and was greatly appreciated, and the excellence of all the arrangements at it reflected the greatest credit on all those concerned in its organization.

EXPEDITION FOR THE STUDY OF TROPICAL DISEASES IN SAMOA

ACCORDING to the London correspondent of the *Journal* of the American Medical Association a new expedition to the tropics for the study of disease is about to start for Samoa under the auspices of the London School of Tropical Medicine. Its main object is the study of filariasis, which affects eighty-five per cent. of the natives of the Pacific Islands. The expedition will be under the direction of Dr. Buxton, a fellow of Trinity College, Cambridge, who is well known for his work in entomology, performed in Mesopotamia during the war, and later as entomologist for the Palestine government in Jerusalem. The expedition will be away for two years and will have its headquarters at Apia. It will work in cooperation with the New Zealand government, which is responsible for the administration of the Samoan group. It is thought that the susceptibility of the Polynesians to disease, especially to tuberculosis, and the decline of their numbers to the extent of threatened extinction, may be due to filariasis. Infection seems to be due to a *Stegomyia* mosquito which is apparently confined to the Pacific Islands. An attempt will be made to eliminate the disease by exterminating the mosquito on lines similar to those that were adopted in Panama and other places. It is thought that the problem is comparatively simple, as the mosquito lives in and around coconut trees and is found in the empty coconut shells, which are stacked in the making of copra. It is proposed to take over a small island a mile or so in diameter, where every breeding place of the mosquito will be effectively dealt with. The native method of storing water is in artificially hollowed coconut trees. It is proposed to substitute, for these, properly constructed cisterns. Moreover, the mosquito does not seem able to exist where the dense undergrowth has been properly cut down. If airways or rides are cut through the dense jungle and the insect is exposed to the trade winds of the Pacific, it may be blown away. An object lesson of this kind can then be applied to the larger islands. Other parasitic diseases prevalent in Samoa, particularly ancylostomiasis, will also be studied. Finally, the effects of the tropical climate on Europeans will be investigated more minutely than has been done previously. The finer methods available since the recent development of biochemistry will be used. Thus, the effect of the sun's rays on the human skin will be investigated with the catathermometer. As an expert ornithologist and entomologist, Dr. Buxton also hopes to bring back a collection of birds and insects (many of which are becoming extinct) for the British Museum.

THE ADJUSTMENT OF AUTOMOBILE HEADLIGHTS

THE Bureau of Standards is conducting work on the better adjustment of automobile headlights. In addition to that carried out locally in the District of Columbia, the bureau is sponsoring a national movement to secure headlight adjustment. A representative of the bureau emphasized the importance of the member club activity in this matter at a meeting of officials of the National Motorists Association in Cleveland, September 20, 21 and 22. This association and the American Automobile Association, as well as all similar organizations, are in a particularly favorable position to place before motorists the necessity for headlight adjustment. The problem has also been discussed in the broadcasting programs which the American Automobile Association sends out through radio station WRC.

The National Automobile Chamber of Commerce is calling the attention of motor car manufacturers to the necessity of closer supervision of their dealer and service activities so that the two or three million new cars turned out annually will have properly adjusted headlights. The Motor and Accessory Manufacturers' Association has made a similar offer to get in touch with headlight manufacturers to insure the furnishing with all headlight devices of simple and adequate instructions for their adjustment. The Society of Automotive Engineers is giving active support through its Standards Committee, particularly along the lines of standardizing and improving headlight construction.

If all headlights could be focused in the same manner, this would simplify the instructions required and facilitate adjustment. In fact, any action taken which may make adjustment easier will be a step forward.

All the national associations approached have

stated that they would actively back a national campaign for headlight adjustment, and some states already have such campaigns under way. Action of this sort should be given all possible support, since proper road lighting will not only reduce the number of accidents, but will make night driving more agreeable. If headlights are adjusted now, a mass of restrictive legislation will be avoided later on.

PROFESSOR COOLEY AND THE ENGINEERING COUNCIL

THE resignation of Mortimer E. Cooley, dean of the College of Engineering and Architecture of the University of Michigan, as president of the American Engineering Council of the Federated American Engineering Societies, was announced at the opening session of a two-day meeting of the Executive Board of the Council held in Rochester, N. Y., October 12.

Dean Cooley, in presenting his resignation to the board, said that he retires on account of ill health. He also made it known that he has been granted leave of absence by the University of Michigan for the second half of the academic year 1923–1924. The executive board adopted a resolution expressing regret that Dean Cooley is forced by ill health to relinquish the presidency of the Federation. The resolution, the adoption of which followed the expression of tributes by leading members of the board, and which was in the nature of an address to Dean Cooley, follows:

Every member of the Executive Board of the American Engineering Council whose deliberations you have led and guided for the past two years listened with the deepest regret to your announcement of the necessity of laying down the duties of the office of president of the Federated American Engineering Societies at the close of this year. Could any reassurance of our support of you and your policies have changed that decision, such assurance would have been at once unanimously tendered.

You took the responsibilities and burdens of our leadership at a most trying hour and in our behalf you have sacrificed both time and health.

With a life-time already devoted to the unification and upbuilding of our profession, you were our outstanding choice to assume the responsibilities of the guidance of our policies. Our faith in you has been more than justified. Coming to us at a time when our organization was almost unknown and of little influence, through your personal prestige and because of your clear vision of the possibilities of service and achievement by a united profession, the Federated Societies have now reached an unassailable position of dignity, respect and public confidence.

For all this and for the steadfastness with which you have revealed your vision to us and to our profession, we thank you.

Though consoled by your promise to still be with the work of the Federated Societies, we shall miss your leadership and something more. Your geniality has been infectious, your sense of humor has relieved many a potentially critical situation, your optimism has brushed aside many difficulties, but above all your personality has drawn us to you and inspired affection. And we shall always be eager for your advice and counsel.

SOCIETIES MEETING AT CINCINNATI

THE following named societies have informed the Washington office of the American Association for the Advancement of Science that they will hold sessions at the approaching Cincinnati meeting, next convocation week. The names and addresses of their secretaries are also given below:

American Mathematical Society (Chicago Section)
Arnold Dresden, 2114 Vilas St., Madison, Wis.

Mathematical Association of America
W. D. Cairns, Oberlin College, Oberlin, Ohio.

American Physical Society
Harold W. Webb, Columbia University, New York, N. Y.

American Meteorological Society
Charles F. Brooks, Clark University, Worcester, Mass.

Association of American Geographers
Richard E. Dodge, Connecticut Agricultural College, Storrs, Conn.

National Council of Geography Teachers
George J. Miller, State Teachers College, Mankato, Minn.

American Society of Zoologists
W. C. Allee, University of Chicago, Chicago, Ill.

Entomological Society of America
C. L. Metcalf, University of Illinois, Urbana, Ill.

American Association of Economic Entomologists
Albert F. Burgess, Melrose Highlands, Mass.

Wilson Ornithological Club
Gordon Wilson, 1434 Chestnut St., Bowling Green, Ky.

Botanical Society of America
I. F. Lewis, University, Va.

American Phytopathological Society
R. J. Haskell, U. S. Department of Agriculture, Washington, D. C.

American Society of Naturalists
A. Franklin Shull, University of Michigan, Ann Arbor, Mich.

Ecological Society of America
A. O. Weese, James Millikin University, Decatur, Ill.

American Microscopical Society
Paul S. Welch, University of Michigan, Ann Arbor, Mich.

American Nature-Study Society
Anne Botsford Comstock, 123 Roberts Place, Ithaca, N. Y.

Metric Association
Howard Richards, 1o6 Fifth Ave., New York, N. Y.

American Society of Agronomy
P. E. Brown, Iowa State College, Ames, Iowa.

American Society for Horticultural Science
C. P. Close, College Park, Md.

Potato Association of America
William Stuart, U. S. Department of Agriculture, Washington, D. C.

Association of Official Seed Analysts
A. L. Stone, University of Wisconsin, Madison, Wis.
Society of Sigma Xi
Edward Ellery, Union College, Schenectady, N. Y.
Gamma Alpha Graduate Scientific Fraternity
H. L. Borst, Ohio State University, Columbus, Ohio.
Phi Kappa Phi Fraternity
C. H. Gordon, University of Tennessee, Knoxville, Tenn.
Phi Delta Kappa Fraternity
Abel J. McAllister, 2118 West 109th St., Chicago, Ill.
Pi Mu Epsilon Mathematical Fraternity
E. D. Roe, Jr., Syracuse University, Syracuse, N. Y.
National Association of Teachers of Speech
H. B. Gough, DePauw University, Greencastle, Ind.

SCIENTIFIC NOTES AND NEWS

PROFESSOR HENRY FAIRFIELD OSBORN, with Mr. Roy Chapman Andrews and other members of the Third Asiatic Expedition of the American Museum of Natural History, left Shanghai for America on October 17.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, who was selected by the seven cooperating institutions (Harvard, Yale, Columbia, Cornell, Pennsylvania and Johns Hopkins Universities, and the Massachusetts Institute of Technology) as exchange professor to France in engineering and applied science for 1923–24, sailed on October 18 to spend the winter lecturing at eight or ten of the principal French universities.

DR. HERBERT E. GREGORY has returned from Honolulu to resume his duties as professor of geology at Yale University. During the summer he visited scientific institutions in New Zealand and served as delegate to the Pacific Science Congress in Australia.

THE National Civil Service Reform League proposes an investigation by Congress of the removal of Arthur Powell Davis as director of the Reclamation Service.

THE Leonard Prize of $500 for research work in X-rays has been given by the American Roentgen Ray Society to Dr. William Duane, professor of biophysics at Harvard University, for his researches in X-ray spectra and methods of estimating the dosage of X-rays to be used in treating diseases.

THE honorary degree of doctor of agriculture of Berlin University was conferred during the past summer on Professor John A. Mandel, of New York University, who was also made an honorary member of the Institute for Experimental Therapeutics at Frankfurt a/M. (Paul Ehrlich Institute) and of the Physiological Society of Berlin.

THE University of Chicago has received a portrait, executed by Mr. Ralph Clarkson, of President James Rowland Angell, of Yale University, who was for twenty-five years professor of psychology at the university and for nine years dean of the faculties. The portrait will be hung in the dining room of the Quadrangle Club.

DR. WILHELM OSTWALD, professor of physical chemistry at Leipzig, reached the age of seventy on September 2.

A SPECIAL volume of the *Zeitschrift für Kristallographie* has been published in honor of the eightieth birthday of the founder and first editor, Professor P. von Groth.

THE Medical Society of London has awarded the Fothergillian Medal and Prize to Sir Arthur Keith.

PROFESSOR BERGONIÉ, of Bordeaux, and Dr. Calmette, subdirector of the Paris Institut Pasteur, have been nominated grand officers of the Legion of Honor.

PROFESSOR G. ARAOZ ALFARO, of Buenos Aires, has been appointed president of the national board of health, a position he had filled temporarily under the previous administration. He has been given full powers to reorganize his department for the purpose of securing greater efficiency.

PAUL M. TYLER, chief of the metals section of the United States Tariff Commission, has resigned.

R. D. RANDS, of the Bureau of Plant Industry, Department of Agriculture, who was transferred last June to the department's rubber project, has recently returned from a trip to Central and South American countries, including Trinidad and the Guianas, where he studied the rubber industry and its disease problems. Dr. Rands, who for several years investigated diseases of plantation rubber for the Dutch East Indian Government, also successfully introduced Hevea and other rubber-yielding plants into Panama where experimental work is now under way.

GERALD H. MAINS has recently resigned as associate chemist of the Color Laboratory of the U. S. Bureau of Chemistry, to accept a position as a chemical engineer with the Westinghouse Electric and Manufacturing Company.

DR. WALDEMAR POSPELOV, director of the Bureau of Entomology of the Agricultural Scientific Committee of Russia, arrived in the United States toward the end of September, after having spent a month in England. Dr. Pospelov occupies the position under the present Russian government that was occupied by the late Professor Porchinsky. Before the war he was professor of zoology in the University of Kiew. He comes to the United States to make some studies of methods in economic entomology and to look into the subject of agricultural education. He visited the Bu-

reau of Entomology at Washington early in October, and then started on a journey to the midwest, stopping at the Ohio State University at Columbus and the University of Illinois at Urbana. On his journey returning, he will visit Cornell, Harvard, the State Agricultural Experiment Station at New Haven and some of the northern stations of the Bureau of Entomology.

PROFESSOR GEORGE A. DEAN, head of the department of entomology at the Kansas State Agricultural College, has been granted a year's leave of absence to be director of the division of cereal crop insect investigation in the Bureau of Entomology.

DR. NUNO GUERNER, Sao Paulo, Brazil, and Dr. Chang H. Han, Tsinghau, China, have been sent to the United States by their respective governments to study public health under the auspices of the International Health Board.

THE International Health Board has awarded scholarships at Johns Hopkins School of Public Health, Baltimore, to five Ohio physicians: Drs. Thomas W. Mahoney, Columbus; Arlington Ailes, Springfield; Clarence D. Barrett, Wooster; Charles Koenig, Toledo, and Roll Markwith, Akron. The scholarships are for one year, and include traveling expenses, maintenance and college fees.

DR. ARTHUR L. DAY, director of the Geophysical Laboratory and chairman of the Advisory Committee on Seismology of the Carnegie Institution, spoke before the Franklin Institute, Philadelphia, on October 17 on "Earthquakes and Volcanic Eruptions."

DR. SELIG HECHT, of Harvard University, delivered an address on the visibility of the spectrum before the Science Club of Amherst College on October 15.

PROFESSOR J. E. ZANETTI, chairman of the Division of Chemistry and Chemical Technology, National Research Council, writes: "I have just discovered that, owing to a misprint in the original French minutes of the meeting of the International Union of Pure and Applied Chemistry, the conversion factor 1 cal. 15° = 1.184 joules was translated without correction and appeared in the abstract of the minutes in your issue of September 28, page 241, column 1, line 7. It should be 1 cal. 15° = 4.185 joules."

UNIVERSITY AND EDUCATIONAL NOTES

BOWDOIN COLLEGE has received a bequest of $500,000 by the will of the late Edward H. Blake.

MRS. MAYER, widow of Levy Mayer, formerly a corporation attorney of Chicago, has given $500,000 to Northwestern University for the erection of a new Law School building. The new building will be named Levy Mayer Hall.

DR. HENRY S. GRAVES, formerly chief of the United States Forest Service and director of the School of Forestry of Yale University, has been elected provost of the university.

A COMPLETE reorganization of the North Carolina State College of Agriculture and Engineering has been largely effected. Five schools have been organized, namely, the School of Agriculture, School of Engineering, School of Social Science, School of Arts and Sciences and the Graduate School. Dr. E. C. Brooks, state superintendent of public instruction, succeeded Dr. W. C. Riddick as president; Dr. B. W. Kilgore, director of the experiment station and director of extension, became also dean of agriculture. Dr. W. C. Riddick has been elected dean of engineering; Professor B. F. Brown, dean of social science; Dr. C. C. Taylor, dean of the graduate school. Appointment has not yet been made of the dean of the School of Arts and Sciences.

DR. HARRISON R. HUNT recently resigned the professorship of biology at the University of Mississippi to become head of the department of zoology and geology, and member of the Agricultural Experiment Station Staff at the Michigan Agricultural College, East Lansing.

DR. J. R. CURRIE, professor of preventive medicine in Queen's University, Kingston, Ontario, has been elected to the newly established Henry Mechan chair of public health at Glasgow.

DR. BELA SCHICK, who invented the well-known test for diphtheria susceptibility, has been made an extraordinary professor of pediatrics in the University of Vienna.

DISCUSSION AND CORRESPONDENCE

FILING REPRINTS

SOME of my scientific friends have urged that I publish a note on a method of keeping reprints which has proved very satisfactory.

Pamphlet boxes, 10 in. high, 1⅜ in. wide and 7 in. deep, are constructed with a wooden front and bottom, cardboard sides, and open top and back. One gets heavy book "boards" (cardboards) cut at a bookbinders, 7 x 10 in. Then one has pine or white wood stock run off at a mill, dressed to ⅜ x 1⅜ in., and cuts them up oneself into lengths of 10 in. and 6⅝ in. The wood top and bottom are fastened together by two brads, and the cardboards are nailed on to the sides with No. 19, ⅝ in., flat head wire nails. Four nails to a cardboard are enough. When one does so much of the labor oneself, the cost of a box is a little less than five cents. There are similar cloth and card-

board boxes on the market, although they are somewhat wider, which cost thirty cents.

The advantage of the open back and top is to remove any limit to the size of the reprints filed. The shelf dimensions with such a box constitute the only limit. The width of the box is its best feature. It is broad enough to stand alone and to permit labeling on the outside which is easily read with the box on the shelf. (Dennison No. 205 labels can be pasted on the outside.) On the other hand, the box is so narrow that it is very little work for one to go through all the reprints in a single box. For this reason it is not necessary in returning a reprint to the box to remove the other reprints and place the particular one with respect to the others. It is enough for one to know that the reprint is in a given box in order to find it quickly.

The small box also allows readily for the expansion of the series at any point, and for the collection of small groups of papers on a given subject or by a given author into a single repository appropriately labeled.

At present I have about 1,800 reprints filed by author in 210 of these boxes. With this distribution the boxes are not full and there is room for considerable expansion without the introduction of new boxes.

EDWIN G. BORING
HARVARD UNIVERSITY

THE PROFESSOR AND HIS WAGES

UNDER this caption appears an article in SCIENCE for August 24 that well illustrates the danger of theorizing without that judgment and knowledge of "how much" that only experience in the field dealt with teaches.

In the first place, the profits assumed for the merchant are much beyond the average, the orderly progress of success rarely exists and the incident worries and troubles and resourcefulness necessary to turn corners are hardly suggested. The risk of capital is quite lightly dismissed. Professor Slosson would doubtless be much surprised to learn that an insurance company, which attempted to underwrite this risk for all those starting in business for themselves, for a 50 per cent. premium, would inevitably bankrupt itself. Yet such is the case.

Of those who attempt business for themselves, even though they have more initiative and self-reliance than the average, fully 90 per cent. are failures and forced to drop out, generally with their capital completely used up. Men, therefore, who succeed in business for themselves, belong to the most severely selected class in the world and certainly not one professor in ten could stick in it. Apply the same severity of selection and the great majority of professors, lawyers, doctors, etc., would drop out, as the majority of business men have. The average professor, then, should not be compared with the successful business man but rather with the latter's employees.

There are, rarely, professors with a genius for teaching—for imparting knowledge—that do work of value hard to estimate and all too little appreciated, and other rare research professors whose work is of inestimable value. These, unhappily, must needs be ill rewarded, largely because but few can appreciate their work or appreciate it during the life-time of the men. Unless a bit sensational, it makes small appeal to the public. But as for the majority, like the great majority of other classes, they get all they are worth to the community. But few of these audible books benefit the community as much as average clerks because their efforts are not directed and coordinated from outside as are those of the clerks.

FRANCIS RALSTON WELSH
NIRVANA, DEVON, PA.

SCIENTIFIC BOOKS

Eighth Report[1] *of the Committee for the Investigation of Atmospheric Pollution. Reports on Observations for the year ending March 31, 1922.* London, 1923.

THE people of London and its environs wash their clothes on Tuesday and themselves on Saturday night. Thus the veil of domestic privacy is ruthlessly torn aside and the secrets of home life no longer held *in camera*. Which is characteristic of this age, for nothing now is hidden. Even the secrets of the structure of matter are pried into, electrons being knocked about by inquisitive physicists; and snug little constituencies known as atoms completely upset and disturbed by some high speed atomic nucleus.

We can prove that the good people of dear old London take their weekly tubbing on Saturday night, because there is a suspicious increase in the number of smoke particles in the air over London at this hour; and these undoubtedly come from domestic fires, lighted or kept going for the purpose of providing sufficient hot water. The Advisory Committee on Atmospheric Pollution have traced such inequalities in the load of suspended impurities to various sources and find that the common dwelling house chimney is the chief offender; even in cities regarded as manufacturing centers. It is not to be wondered at either, for *en masse* these little smokers pour out a vast volume of products of imperfect combustion.

This Eighth Report is the most ambitious effort yet made and shows that the Committee is getting into its stride and obtaining results of great value. The work differs from most pieces of experimental work in

[1] Previous reports have been reviewed in SCIENCE, June 2, 1922, April 22, 1921, and November 28, 1919.

chemistry or physics, in that it is carried on, not in a university laboratory, but in the larger laboratory of out-of-doors and the results therefore are applicable without regard to scale and other uncertainties.

The work done during the year falls under eight sections, namely, (1) the monthly amounts obtained by standard gages, tabulated and analyzed; (2) new type of gage; (3) influence of a Nipher wind shield on the amount collected; (4) the Rochdale deposits; (5) the automatic filter; (6) a jet apparatus for the isolation and examination of atmospheric dust; (7) researches on obscurity and visibility; (8) relations with other organizations.

Thirty-one gages were operated during the year, of which 8 were in London. Data are now available for five years, in many cases, and so comparisons can be made with a view of getting monthly or seasonal departures from mean conditions.

The old unit for amount of deposited matter, namely, the metric ton per square kilometer, has been altered to simplify printing. The amounts heretofore given to two decimal places have been multiplied by 100 and can be read as metric tons per hundred square kilometers and the same figures express the weight in grams over 100 square meters. The gram per square dekameter, $gm/(10m)^2$, seems to be a practical and economical anit.

The year was one of exceptionally fine, clear weather; and also there was a coal strike from April 1 to July 4. The amounts of pollution are below the average and the influence of the coal strike can be clearly traced.

An interesting point brought out by the Rochdale experimental records, is that the impurity of the air is not particularly due to an influx from neighboring polluted areas. By means of twin gages, one collecting material brought by east winds and the other by west winds, it is shown that the high deposit at this place is not due to impurities carried into town by the west wind.

Again during the stoppage of coal and the closing down of factories, duplicate gages made it plain that factory smoke was responsible only for about 66 per cent. of the pollution.

A rough estimate is
Dust 15 per cent.
Factory smoke 66 per cent.
House smoke et al. 19 per cent.

Many interesting graphs are given showing conditions on foggy and non-foggy days.

There is a detailed description of the new jet apparatus dust counter of Dr. J. S. Owens, an instrument which is within reach of the laity.

Near the end of the Report there is a handy bibliography of dust investigations.

ALEXANDER MCADIE

SPECIAL ARTICLES

THE INFLUENCE OF THE TEMPERATURE OF THE SOIL ON THE RELATION OF ROOTS TO OXYGEN

THE rate of root growth of land plants, under normal conditions of aeration, is known to be influenced by the temperature of the substratum in such manner that there are three well defined temperatures of growth, namely, the highest at which growth is possible, the temperature at which growth is most active, and the temperature below which growth ceases. Under conditions of a diminished supply of oxygen, however, these cardinal temperatures of growth appear to be greatly modified. This feature has physiological and ecological bearing of some interest.

In *Potentilla anserina*, which occurs in swampy ground, with the roots in 1.2 per cent. oxygen and the balance nitrogen, the growth of the roots is various. Thus at 27° and 30° C. growth does not take place, but at 18° it is about one fourth normal for that temperature. When given experimental atmosphere containing 2 per cent. oxygen the growth rate is about one fourth normal at 30°, one third normal at 27° and normal at 18° C.

In a garden variety of corn with roots in 3 per cent. oxygen the effect on the rate of growth is quite as striking as in the case of Potentilla. For example, at 30° it is about one sixteenth normal, 20° it is about one fifth normal and at 18° it is about one third normal. When the percentage of oxygen is increased to 3.6 the rate of growth is much increased. For example, at 30° the rate is about one third the expected rate under normal aeration conditions, while at 18° it is about two thirds normal. While in 10 per cent. oxygen the rate at 30° is about nine tenths normal and at 18° it is normal.

In the two species referred to, and the same is true of several species studied, the relative rate of root growth, that is, the rate under given oxygen conditions as compared to the expected rate in normal conditions of aeration, decreases with the increase in the temperature of the soil. It can be seen, therefore, that there comes a point in the diminution of the oxygen content of the soil atmosphere when the growth of the root ceases because it is no longer sufficient to supply the demands for energy correlated with physiological activities of higher temperatures. The diminution of the oxygen supply of a consequence becomes a factor limiting the growth of the root, and which, as the above citations indicate, may have specific value.

Some observations on modifications of the cardinal temperatures for root growth resulting from deficiency of oxygen indicate that the conclusion as stated in the preceding paragraph may in some manner in-

fluence such as well. Thus the maximum temperature for root growth of *Opuntia versicolor* is about 42° under normal conditions of aeration, but when the percentage of oxygen is reduced to 1.2 no growth occurs at 30° although it may go on at 20°. This being the case, both the optimum as well as the maximum temperature for growth are greatly reduced.

The optimum temperature for the growth of the shoot in corn is about 33.7° and the maximum temperature is about 46.5°, while the corresponding temperatures for the root are probably somewhat less. In percentages of oxygen less than 10, and except as indicated above, and for soil temperatures below 30°, the growth rate is below normal. However, in 3.6 per cent. oxygen the most rapid growth rate is about 30°, but when the amount of oxygen is reduced to 3 per cent., 20° is apparently about the optimum temperature for growth.

Observations on the relation of the roots of the Rough lemon to the oxygen supply at relatively low soil temperatures indicate that the minimum temperature under certain conditions may also be modified. The Rough lemon has apparently a fairly high minimum temperature for root growth, or at least the rate of growth under normal conditions of soil aeration is relatively slow at 18° C. In 2 per cent. oxygen, however, although growth continues at 26° and at 22°, it does not go on at 20° or at 18° C. In this instance the minimum temperature for growth may have been raised.

The observations above summarized on the relation of root growth to the oxygen supply are apparently in accord with the known variation in the respiratory ratio (of the shoot) which is associated with differences in temperature, being least at those that are medium, that is 15° C., or less.[1]

The ecological bearing of the influence of the temperature of the soil on the oxygen relation of roots can only be suggested. The ecological significance of soil aeration has been referred to in an earlier paper[2] and it need merely be suggested in this place that the oxygen relations of the species with especial regard to the temperature of the soil should also be taken into account. It is quite clear from the summary above given of typical results in relation to several species, and which can probably be extended to other species as well, that in puddled soils with consequent poor aeration, and in summer, the matter of oxygen supply to the roots must be acute. And, in certain species, as, for instance in varieties of corn, in order to attain to a fair rate of root growth at a time of high soil temperatures the aeration of the soil must be good indeed, otherwise, as shown in another paragraph, the rate of growth is very considerably cut down.

The conclusions arrived at and as reported in this notice offer additional reasons for extensive studies on the temperature-aeration relations of the soil, and suggest the desirability of intensive investigations on the oxygen relation of roots as an important physiological factor of ecological moment.

W. A. CANNON

COASTAL LABORATORY,
CARMEL, CALIFORNIA

[1] Palladin's "Plant Physiology," Livingston, p. 190.

[2] "The Ecological Significance of Soil Aeration," W. A. Cannon and E. E. Free, SCIENCE, N. S., Vol. 45, p. 178, 1917.

DISPERSITY OF SILVER HALIDES IN RELATION TO THEIR PHOTOGRAPHIC BEHAVIOR

IN a recent article appearing in the *Journal of Physical Chemistry*, 27, 1–51, Wightman, Trivelli and Sheppard report that in general the larger the silver halide grain and the larger the range in grain size in the emulsion, the more rapid the paper in its action towards light. The authors support their conclusions by means of exhaustive research by means of photomicrographs. There can be no doubt that in the case of their experiments "the relative speed of the emulsions increases rapidly with the increase of average size and range of size of the particles contained therein." However, that this is not always the case is shown by the example quoted in the Eastman Monograph No. 1, p. 104, written by Trivelli and Sheppard, where comparison of two emulsions showed that the one having grains one third the linear dimensions was more than 19 times as fast and that the same was true of individual grains in the same emulsion. Koch and Du Prel (*Physik. Zeit.*, 17, 536 (1916)) conclude that it is not possible to formulate a definite relationship between the grain size and sensitivity with the information at present available, but that it is certain that the largest grains in an emulsion are by no means the most sensitive.

Theoretical consideration: On the basis of the nuclear theory, the speed should depend on the *number of grains affected,* on the basis of the sub-halide theory, the speed should depend on the *amount of halide* affected. From both the continuous wave theory and the quantum theory of light the number of grains affected or the amount of halide affected should increase with the dispersity. Theoretically, then, the smaller grained emulsions should be more sensitive.

Discrepancy between the results of Wightman, Trivelli and Sheppard and the theoretically expected results is perfectly explained by adsorption. Adsorption increases with specific surface, the latter increasing with dispersity. The retarding effect of the adsorbed halide might neutralize or completely reverse the purely dimensional effect. With much adsorption we should expect the sensitivity to be inversely proportional to the adsorption or inversely proportional to the dispersity. Hence the larger-grained

emulsion would be more sensitive. The effect of range of size can also be explained by adsorption as the small grains adsorb relatively more soluble halide than the larger ones, leaving the larger ones relatively freer and therefore more sensitive than if the small ones had not been present.

Experiments performed in this laboratory show that large-grained emulsions are more sensitive when unsensitized, but that after sensitization the relative speeds are reversed. The sensitization process used is one of removing adsorbed retarding halide. We are forced to conclude that intrinsically small-grained emulsions are faster; that adsorbed halide may neutralize or reverse the purely dimensional effect so that where there is much adsorption the large-grained ones seem the faster; that unless one knows not only the ratio of size of the grains, but also relative amounts of adsorbed retarders, it is impossible to predict the relative speeds of two emulsions.

The above investigation is at present nearing completion, and the complete results will be published in the near future.

FRANK E. E. GERMANN
MALCOLM C. HYLAN
DEPT. OF THEORETICAL AND PHYSICAL CHEMISTRY, UNIVERSITY OF COLORADO

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE LOS ANGELES MEETING

THE seventh annual meeting of the Pacific Division held in conjunction with the fourth annual meeting of the Southwestern Division and the summer session of the American Association for the Advancement of Science at Los Angeles from September 17 to 20, 1923, was from every point of view a pronounced success.

While the various eclipse expeditions of the preceding week had in most cases been somewhat disappointing on account of weather conditions, yet the occasion of the eclipse had drawn together many distinguished astronomers from all parts of the world and their assemblage under the auspices of the Pacific Division was a dominating feature of the Los Angeles meeting.

The symposium on "Eclipses and Relativity" on the opening day of the meeting proved to be a very attractive feature of the general sessions and was largely attended.

The Research Conference, held at the luncheon hour on Monday, September 17, was participated in by practically the entire convention and the following program was presented:

Research activities of the California Institute of Technology: PROFESSOR EARNEST C. WATSON, California Institute of Technology, Pasadena.

The Scripps Institution: ACTING DIRECTOR F. B. SUMNER, Scripps Institution for Biological Research, La Jolla.

The causes of variation in yield in citrus trees: ACTING DEAN HERBERT J. WEBBER, University of California Agricultural Experiment Station, Riverside.

Petroleum research: DR. LAIRD J. STABLER, University of Southern California, Los Angeles.

On Monday evening, September 17, the meeting was formally opened with an address of welcome by President von KleinSmid, of the University of Southern California, to which response was made by Dr. C. E. Grunsky, chairman of the executive committee.

The address of the retiring president, Professor E. P. Lewis, of the University of California, was then delivered. Dr. Lewis chose as his subject: "The contributions of astronomy to civilization," thus further emphasizing the astronomical character of the Los Angeles meeting. He gave a masterly survey of the progress of astronomical knowledge from the earliest times showing that the race has benefited not only materially but ethically and spiritually through the labor of astronomers. He held out the hope that through the discoveries of Einstein and others some of the most illusive problems of space and time may be brought within the range of human comprehension. As a notable contribution to a popular understanding of these abstruse questions the publication of this address in SCIENCE will be welcomed.

Wednesday evening, September 17, Dr. John C. Merriam, president of the Carnegie Institution of Washington, spoke on "The meaning of history as illustrated by the records secured at Rancho La Brea." The perfect preservation of the specimens entrapped in the asphalt beds of La Brea and the wonderful succession of life represented constitutes a unique historical record and furnishes indubitable proof of the evolution of existing species from these remote types. It is hoped that Dr. Merriam will arrange the substance of this interesting address for publication.

Dr. R. B. von KleinSmid, president of the University of Southern California, gave an interesting discourse on the "Psychology of Crime," a subject in which he has specialized for many years. It was a notable addition to the program provided for the general sessions.

Too much can not be said in praise of the very efficient preparations made for the meeting by the local committees. The accommodations for the various meetings of the affiliated societies were all that could be desired and the courteous hospitality extended to visitors was the occasion of much favorable comment.

Over 500 registered for the meetings, including 253 members of the association. Twenty-three affiliated societies held meetings under the auspices of the Pacific Division. Reports of some of these meetings,

as submitted by their secretaries, will be printed in SCIENCE.

W. W. SARGEANT
Secretary, Pacific Division American Association for the Advancement of Science

JOINT MEETINGS OF THE AMERICAN ASTRONOMICAL SOCIETY, THE ASTRONOMICAL SOCIETY OF THE PACIFIC, AND SECTION D OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ON the first day, September 17, the sessions were held at the University of Southern California, Los Angeles; on the second day, in Pasadena—in the morning, at the office of the Mount Wilson Observatory, and in the afternoon, at the Norman Bridge Laboratory of the California Institute of Technology, in conjunction with the physicists; on the third day, in the dome of the 100-inch Hooker telescope on Mount Wilson.

There was throughout a large attendance of professional and amateur astronomers. Eastern and western observatories in the United States were well represented, and in addition there were astronomers from Canada, Mexico, Australia, Japan, Argentina, England, Spain, France, Belgium and Holland.

The symposium on eclipses and relativity on the afternoon of the first day attracted a large audience. There were four addresses, as follows:

Some conditions apparently existing in the solar corona: DR. W. W. CAMPBELL, president, University of California.

How the spectrum of the sun's atmosphere is studied at eclipses and the interpretation of the results through the aid of modern physics: DR. S. A. MITCHELL, director, McCormick Observatory, University of Virginia.

The constitution of the sun's atmosphere, the levels of the gases and the nature of their circulation. Results bearing on the displacements of solar spectrum lines as required by the theory of relativity: DR. CHARLES E. ST. JOHN, astronomer, Mount Wilson Observatory, Pasadena.

Relativity as represented by the Einstein-eclipse problem: DR. R. J. TRUMPLER, assistant astronomer, Lick Observatory, Mount Hamilton.

The last two speakers dealt with the bearing of recent observations on the theory of relativity. Dr. St. John's paper contained the important announcement that an exhaustive discussion of wave-lengths of lines in the solar spectrum has led him to the conclusion that the pressure in the reversing layer is negligible, and that after the effects of radial motion and scattering have been eliminated there remain differences between solar and laboratory wave-lengths of the order called for by the Einstein theory. Dr. Trumpler explained in detail the good agreement found on the Lick Observatory plates of the 1922 eclipse between the measured displacements of stars near the sun, and those predicted by the theory of relativity. Results obtained at the eclipse of September 10, 1923, were reported by Professors Brackett, Worthington, Miller, Douglass and Gallo.

About one hundred and thirty persons made the trip to Mount Wilson on the third day. Most of them remained until evening to look through the 60-inch and 100-inch telescopes.

The technical papers presented at the various sessions were as follows:

Some vagaries of refraction: ARTHUR J. ROY, Dudley Observatory.

Recent latitude results at Lick Observatory: R. H. TUCKER, Lick Observatory.

Notes on proper motions: A. VAN MAANEN and HANNAH M. MARSH, Mount Wilson Observatory.

Fundamental consideration on researches relating to minor planets: A. O. LEUSCHNER, University of California.

Radial velocities of stars of spectral class R: R. F. SANFORD, Mount Wilson Observatory.

Hypothetical parallaxes of 135 A double stars measured at three or more epochs: R. G. AITKEN and MARGARET POWELL, Lick Observatory.

The radial velocities of long-period variable stars: PAUL W. MERRILL, Mount Wilson Observatory.

Some properties of the stars in space as derived from the near-by stars: W. J. LUYTEN, Harvard Observatory.

A new catalogue of variable stars: S. D. TOWNLEY, Stanford University.

Three stellar spectroscopic notes: W. S. ADAMS and A. H. JOY, Mount Wilson Observatory.

A possible origin of the nebular lines: H. H. PLASKETT, Dominion Astrophysical Observatory.

The possibilities of instrumental development: GEORGE E. HALE, Mount Wilson Observatory.

On Atmospheric Absorption: H. L. VANDERLINDEN, Observatoire Royal, Uccle, Belgium.

The sun's action on the magnet, a note on variable stars and cosmic clouds: LUIS RODÉS, Observatorio del Ebro, Spain.

The radiation from mercury compared with the radiation from other planets: EDISON PETTIT and SETH B. NICHOLSON, Mount Wilson Observatory.

Asymmetry in the distribution of stellar velocities: GUSTAF STRÖMBERG, Mount Wilson Observatory.

Stellar interferometer work during 1922–1923: F. G. PEASE, Mount Wilson Observatory.

Density distribution in the photographic images of elliptical nebulae: EDWIN HUBBLE, Mount Wilson Observatory.

Radial velocity measurements of the spectrum of omicron ceti: ALFRED H. JOY, Mount Wilson Observatory.

On account of lack of time the following papers were read by title:

The systematic corrections to Boss's preliminary general catalogue: WILLIAM B. VARNUM, Dudley Observatory.

Jupiter's third satellite: W. H. PICKERING, Harvard Observatory Station, Jamaica.

Relativity: An approximation: CHARLES LANE POOR, Columbia University.

The number and distribution of stars with Class B spectra having emission lines: RALPH H. CURTISS, University of Michigan Observatory.

Progress with color-index apparatus: EDWARD S. KING, Harvard Observatory.

Methods and results of the absolute magnitude determination of stars at the Dominion Astrophysical Observatory: W. E. HARPER and R. K. YOUNG, Dominion Astrophysical Observatory.

The spectral parallaxes of double stars: FREDERICK C. LEONARD, University of California.

Mean absolute magnitudes of the long-period variables and other stars of late types: RALPH E. WILSON, Dudley Observatory.

Atmospheric pulsation of cepheids, a method of attack: W. CARL RUFUS, University of Michigan Observatory.

Remarks on the luminosity function: F. H. SEARES, Mount Wilson Observatory.

On the orbit of the brighter component of Beta Lyrae: R. A. ROSSITER, University of Michigan Observatory.

The absorption lines of O-type stars: J. S. PLASKETT, Dominion Astrophysical Observatory.

Regularities in the arc spectrum of Zirconium: C. C. KIESS and HARRIET KNUDSEN KIESS, U. S. Bureau of Standards.

An Arctic episode in astronomy: R. H. TUCKER, Lick Observatory.

Two new camera lenses for spectrographs: J. S. PLASKETT, Dominion Astrophysical Observatory.

The orbits of the spectroscopic components of Boss 6148: W. E. HARPER, Dominion Astrophysical Observatory.

The orbit of the spectroscopic binary Boss 1452: W. E. HARPER, Dominion Astrophysical Observatory.

The wedge method and its application to astronomical spectrophotometry: H. H. PLASKETT, Dominion Astrophysical Observatory.

Photo-electric photometry at the Washburn Observatory: JOEL STEBBINS, University of Wisconsin.

The radial displacements in the Wallal photographs: WILLIAM B. VARNUM, Dudley Observatory.

Regularities in the spectrum of titanium: HENRY NORRIS RUSSELL, Princeton University.

Abstracts of the papers will be published as usual in *Popular Astronomy.*

JOEL STEBBINS
Secretary, American Astronomical Society

AMERICAN METEOROLOGICAL SOCIETY

ONE of the largest and most interesting meetings of the American Meteorological Society was held at the University of Southern California, on September 17, 18 and 19. The meeting was held conjointly with those of the Pacific and Southwestern Divisions of the American Association for the Advancement of Science and our Society enjoyed all the privileges obtained by the larger societies. The first session was devoted largely to evaporation problems and it was brought out in the discussion that none of the methods used were entirely satisfactory to engineers. Dr. George F. McEwen closed the discussion by stating that he believed the Calculation Process to be best for large bodies of water, whereby an equation based on isolation is used. Later Mr. Charles E. Grunsky offered the following resolution. which was passed with no dissenting votes:

RESOLVED, that the study of evaporation from open bodies of water should be extended, with particular references to the standardization of methods of observation, in order that known meteorological conditions may better serve as a basis for predicting evaporation losses from such water bodies.

The next session was largely devoted to the discussion of the problems of the Lower Colorado River as caused by mountain snowfall and flood crests. The discussions were unusually interesting as the problem is an international one. The people of the United States have spent great sums—five or six million dollars—on a project located in Mexican territory, for the purpose of conserving water for use in our country as well as in Mexico. Resolutions were passed covering this problem as follows:

Being impressed with the importance of flood control and other problems of the Lower Colorado River and the necessity for an early solution thereof, and realizing that the solution of these problems requires action by the United States because of their interstate and international aspects, BE IT RESOLVED by the American Meteorological Society that the attention of the Executive Committee of the Pacific Division of the American Association for the Advancement of Science be called to the present situation with the suggestion that the Pacific Division place itself on record as favoring early action by the United States to accomplish the permanent solution of these Colorado River problems.

The third session was taken up in discussing matters pertaining to forecasting the weather, and Mr. L. E. Blochman brought to light some interesting facts regarding the probabilities of long range forecasting based upon the geographical location of low pressure areas entering the United States from the Pacific Ocean.

The morning session of the last day was made most interesting by the presence of two aviators, Messrs. Wyatt and Lawing, from the Air Field at San Diego, who flew to Los Angeles that morning in a plane

especially prepared for taking meteorological observations while aloft. These men left their station in San Diego for Los Angeles at about the same time the other members of our society left their hotels for the meeting place at the University of Southern California. They arrived promptly at 9 a. m. and gave most interesting talks regarding upper air conditions over the southwest portion of California, based upon almost daily observation taken during the last two years by these gentlemen.

The afternoon session, which concluded the series, was specially devoted to the influences of weather upon forest fires. It was brought out at this meeting that humidity was even more important than wind in starting, spreading and stopping forest fires.

It was proved that the United States Weather Bureau could be of great help in forewarning fire-fighters of dangerous conditions and the following resolution was submitted and passed unanimously:

WHEREAS, the conservation of the remaining forest area and the reforestation of large areas already cut over are largely dependent on the prevention and control of forest fires, and

WHEREAS, in the prevention and control of forest fires a fore-knowledge of the weather is most important, and

WHEREAS, the making of weather forecasts for forest areas is difficult, because most of the observation stations are outside these areas; therefore be it

RESOLVED, that the Congress be asked to appropriate such funds as are needed to provide meteorological stations in the forest areas and to make adequate study of forest weather and to apply the results of this study to forest fire prevention and control.

Votes of thanks were given to the Pacific Division of the American Association for the Advancement of Science and to the University of Southern California for the conveniences afforded the meetings of our society. After which it adjourned *sine die*.

E. A. BEALS,
Secretary pro tem.

THE AMERICAN PHYSICAL SOCIETY

THE one hundred and twenty-second regular meeting of the American Physical Society was held in the Norman Bridge Laboratory of Physics, California Institute of Technology, Pasadena, on September 18, 1923. The morning session was a session of the Physical Society alone, and the afternoon session was a joint session with the American Astronomical Society. The attendance was about sixty. The presiding officer was Professor E. C. Watson.

Papers presented at the morning session and those contributed by the Physical Society to the afternoon session were as follows:

The physical characteristics of diplacusis: V. O. KNUDSEN and GEO. E. SHAMBAUGH, University of California, Southern Branch.

Interference phenomena with a thick glass plate in the path of one of the interfering beams: W. N. BIRCHBY, Norman Bridge Laboratory of Physics, California Institute of Technology.

On the condition known as electrical neutrality: FERNANDO SANFORD, Stanford University.

A method of comparing the rates of mixing of two liquids: L. E. DODD, University of California, Southern Branch.

The crystal structure of benzene: JARED KIRTLAND MORSE, Ryerson Physical Laboratory, University of Chicago.

Oscillograms of the barkhausen effect: S. R. WILLIAMS, Norman Bridge Laboratory, California Institute of Technology.

Magnetic results obtained by the Carnegie during cruises IV, V and VI: J. P. AULT, Carnegie Institution of Washington.

Accurate measurements of the energy content of extreme ultraviolet mercury lines, and the precise determination of the photoelectric long-wavelength limit of a clean surface of mercury: C. B. KAZDA, Norman Bridge Laboratory, California Institute of Technology.

Effect of temperature and surface impurities on photocurrents with aluminum surfaces from which surface films have been removed by melting in vacuo: J. REED NIELSEN, Norman Bridge Laboratory, California Institute of Technology.

Magnetic beta ray analysis of soft x-rays: JOSEPH A. BECHER, Norman Bridge Laboratory, California Institute of Technology.

The pulling of electrons out of metals by intense electrical fields: R. A. MILLIKAN and CARL F. EYRING, Norman Bridge Laboratory, California Institute of Technology.

The appearance of certain ghosts in the general x-ray spectrum formed by reflection from calcite; an explanation of their cause and the means of their elimination: A. E. HENNINGS, Stanford University.

The influence of the scattering substance on the wave length and intensity of scattered x-rays: P. A. ROSS, Stanford University.

JOINT SESSION WITH THE AMERICAN ASTRONOMICAL SOCIETY

Effects of a total solar eclipse on the earth's magnetic and electric fields: J. P. AULT, Carnegie Institution of Washington.

Photographic film characteristics in the ultraviolet: GEORGE R. HARRISON and CEDRIC E. HESTHAL, Stanford University.

Extreme ultraviolet spectra: R. A. MILLIKAN and I. S. BOWEN, Norman Bridge Laboratory of Physics, California Institute of Technology.

The vacuum spark spectrum of calcium: J. A. ANDERSON, Mt. Wilson Solar Observatory.

Series spectra in oxygen and sulphur: J. J. HOPFIELD, University of California.

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